REMARKS

The Office Action dated April 18, 2007 has been received and carefully noted. The above amendments to the claims, and the following remarks, are submitted as a full and complete response thereto.

Claims 1-15 have been amended to more particularly point out and distinctly claim the subject matter of the invention. Claim 16 has been canceled without prejudice or disclaimer. New claims 18 and 19 have been added. No new matter has been added. Therefore, claims 1-15 and 17-19 are currently pending in the application and are respectfully submitted for consideration.

The Office Action rejected claims 15-17 under 35 U.S.C. §101 as allegedly being directed to non-statutory subject matter. In particular, the Office Action noted that claims 15-17 are not directed to a process, machine, manufacture, or composition of matter. Claim 15 has been amended to clarify that the computer program product is embodied on a computer-readable medium and controls a computer to perform certain functions. Claim 16 has been canceled. Accordingly, Applicants submit that claims 15 and 17 are directed to statutory subject matter.

The Office Action rejected claims 1-2, 5-10, and 13-17 under 35 U.S.C. §103(a) as being unpatentable over Coersmeier ("Frequency Selective IQ Phase and Amplitude Imbalance Adjustments for OFDM Direct Conversion Transmitters") in view of Yuda (U.S. Patent Pub. No. 2005/0018597). The Office Action took the position that

Coersmeier discloses all of the elements of the claims, with the exception of N signal branches. The Office Action then cited Yuda as allegedly curing this deficiency in Coersmeier. The rejection is respectfully traversed for at least the following reasons.

Claim 1, upon which claims 2-5 are dependent, recites an error adjustment system for equalizing transmission characteristics of N signal processing circuitries according to N signal branches (N>1). The system includes a generating unit configured to generate an original complex time domain IQ signal for N signal branches, and N error correction units according to the N signal branches, each configured to perform error correction on the original complex time domain IQ signal of a respective signal branch by means of a correction function. The system further includes N signal processing circuitries according to the N signal branches, each configured to process the corrected complex time domain IQ signal of the respective signal branch, thereby obtaining a processed real signal of the respective signal branch, and a processing device. The processing device includes a receiving unit configured to receive an original complex time domain IQ signal of a signal branch of the N signal branches generated by the generating unit and a processed real signal of the signal branch, a first calculating unit configured to calculate a processed complex time domain IQ signal of the signal branch from the processed real signal and the original complex time domain IQ signal of the signal branch, a second calculating unit configured to calculate a difference between the processed complex time domain IQ signal and the original complex time domain IQ signal, a third calculating unit configured to calculate control values of a correction function of the signal branch on the

basis of the difference calculated by the second calculating unit, and a supplying unit configured to supply the control values calculated by the third calculating unit to the correction function of the signal branch. The receiving unit, the first to third calculating units and the supplying unit are configured to repeat their operations for all N signal branches.

Claim 6, upon which claims 7 and 8 are dependent, recites a processing device for an error adjustment system for equalizing transmission characteristics of N signal processing circuitries according to N signal branches (N>1). The device includes a receiving unit configured to receive an original complex time domain IQ signal of a signal branch of N signal branches and to receive a processed real signal of the signal branch, a first calculating unit configured to calculate a processed complex time domain IQ signal of the signal branch from the processed real signal and the original complex time domain IQ signal of the signal branch, a second calculating unit configured to calculate a difference between the processed complex time domain IQ signal and the original complex time domain IQ signal, a third calculating unit configured to calculate control values of a correction function of the signal branch on the basis of the difference calculated by the second calculating unit, and a supplying unit configured to supply the control values calculated by the third calculating unit to the correction function of the signal branch. The receiving unit, the first to third calculating unit and the supplying unit are configured to repeat their operations for all N signal branches.

Claim 9, upon which claims 10-13 are dependent, recites an error adjustment method of equalizing transmission characteristics of N signal processing circuitries according to N signal branches. The method includes generating an original complex time domain IQ signal for N signal branches, and, in each of the N signal branches, performing error correction on the original complex time domain IQ signal by means of a correction function and processing the corrected complex time domain IQ signal in a signal processing circuitry, thereby obtaining a processed real signal. In a processing device, receiving an original complex time domain IQ signal of a signal branch of the N signal branches generated and a processed real signal of the signal branch, first calculating a processed complex time domain IQ signal of the signal branch from the processed real signal and the original complex time domain IQ signal of the signal branch, second calculating a difference between the processed complex time domain IQ signal and the original complex time domain IQ signal, third calculating control values of a correction function of the signal branch on the basis of the difference calculated in the second calculating, supplying the control values calculated in the third calculating to the correction function of the signal branch, and repeating the steps performed in the processing device for all N signal branches.

Claim 14 recites a method of equalizing transmission characteristics of N signal processing circuitries according to N signal branches. The method includes first calculating a processed complex time domain IQ signal of a signal branch of N signal branches from a processed real signal and an original complex time domain IQ signal of

the signal branch, second calculating a difference between the processed complex time domain IQ signal and the original complex time domain IQ signal, third calculating control values of a correction function of the signal branch on the basis of the difference calculated in the second calculating, and repeating the first to third calculating for all N signal branches.

Claim 15, upon which claim 17 is dependent, recites a computer program product, embodied on a computer-readable medium, the computer program product comprising software code portions for controlling a computer to perform the following: first calculating a processed complex time domain IQ signal of a signal branch of N signal branches from a processed real signal and an original complex time domain IQ signal of the signal branch, second calculating a difference between the processed complex time domain IQ signal and the original complex time domain IQ signal, third calculating control values of a correction function of the signal branch on the basis of the difference calculated in the second calculating, and repeating the first to third calculating for all N signal branches.

Claim 18 recites an error adjustment system for equalizing transmission characteristics of N signal processing circuitries according to N signal branches (N>1). The system includes generating means for generating an original complex time domain IQ signal for N signal branches, N error correction means according to the N signal branches, each for performing error correction on the original complex time domain IQ signal of a respective signal branch by means of a correction function, N signal

processing means according to the N signal branches, each for processing the corrected complex time domain IQ signal of the respective signal branch, thereby obtaining a processed real signal of the respective signal branch, and a processing device. The processing device includes receiving means for receiving an original complex IQ time domain signal of a signal branch of the N signal branches generated by the generating means and a processed real signal of the signal branch, first calculating means for calculating a processed complex time domain IQ signal of the signal branch from the processed real signal and the original complex time domain IQ signal of the signal branch, second calculating means for calculating a difference between the processed complex time domain IQ signal and the original complex time domain IQ signal, third calculating means for calculating control values of a correction function of the signal branch on the basis of the difference calculated by the second calculating means, and supplying means for supplying the control values calculated by the third calculating means to the correction function of the signal branch. The receiving means, the first to third calculating means and the supplying means are configured to repeat their operations for all N signal branches.

Claim 19 recites a processing device for an error adjustment system for equalizing transmission characteristics of N signal processing circuitries according to N signal branches (N>1). The device includes receiving means for receiving an original complex time domain IQ signal of a signal branch of N signal branches and receiving a processed real signal of the signal branch, first calculating means for calculating a processed

complex time domain IQ signal of the signal branch from the processed real signal and the original complex time domain IQ signal of the signal branch, second calculating means for calculating a difference between the processed complex time domain IQ signal and the original complex time domain IQ signal, third calculating means for calculating control values of a correction function of the signal branch on the basis of the difference calculated by the second calculating means, and supplying means for supplying the control values calculated by the third calculating means to the correction function of the signal branch. The receiving means, the first to third calculating means and the supplying means are configured to repeat their operations for all N signal branches.

Thus, according to embodiments of the present invention, a software-hardware approach is provided which reduces the amount of N different pre-equalizers to only a single pre-equalizer implementation for the overall multi-antenna transmitter.

As will be discussed below, the combination of Coersmeier and Yuda fails to disclose or suggest all of the elements of the claims, and therefore fails to provide the advantages and features discussed above.

Coersmeier discloses time domain adjustment techniques which employ a decision directed IQ amplitude and filter pre-equalizer. The non-decision aided IQ phase adjustment provides a pre-equalizer-like architecture and processes a certain amount of time domain coefficients. Coersmeier also discloses implementing the IQ error detection algorithms via software on a Digital-Signal-Processor (DSP) and the IQ error corrections via hardware in an ASIC or FPGA.

Yuda discloses a radio base-station apparatus. The apparatus includes a transmission weight computing section for computing a transmission weight for directional transmission using an OFDM signal, a transmission correcting value memory section for storing one correcting value for correcting the transmission weight for each sub-carrier of an OFDM signal or each band gathering a plurality of sub-carriers, a transmission weight correcting section for correcting the transmission weight by the correcting value, and a transmitting branch for weighting transmission data with a transmission weight outputted from the transmission weight correcting section on a sub-carrier-by-sub-carrier basis and deliver it to an antenna element.

Applicants respectfully submit that Coersmeier and Yuda, whether considered alone or in combination, fail to disclose or suggest all of the elements of the present claims. For example, the combination of Coersmeier and Yuda does not disclose or suggest "N error correction units according to the N signal branches, each configured to perform error correction on the original complex time domain IQ signal of a respective signal branch by means of a correction function," as recited in claim 1 and similarly recited in claim 9. The combination of Coersmeier and Yuda also fails to disclose or suggest "a first calculating unit configured to calculate a processed complex time domain IQ signal of the signal branch from the processed real signal and the original complex time domain IQ signal of the signal branch," as recited in claim 6 and similarly recited in claims 14 and 15.

It is an object of the present invention to improve the signal accuracy at a direct conversion architecture output of a multi-antenna transmitter and at the same time reduce an implementation amount of the multi-antenna transmitter. According to embodiments of the invention, therefore, an original complex time domain IQ signal is generated for N signal branches (see Figure 2, block 3), and this time domain IQ signal is processed.

As acknowledged by the Office Action, Coersmeier only discloses one branch of a direct conversion transmitter analog front-end. Yuda, as discussed above, discloses a radio base station apparatus for sending a signal of an OFDM modulation scheme, and which has an array antenna made up of a plurality of antenna elements. The radio base station apparatus comprises a transmitting-data generating section 100 which generates information to be sent and outputs a transmitting-data string. A weight operating section 102 controls the amplitude and phase of a signal radiated at antenna elements, thereby enabling directional sending of signals. A transmission branch 101-1, 101-2, ..., 101-N is configured with a weight operating section 102-1, 102-2, ..., 102-N, an inverse fast Fourier transform (IFFT) operating section 103-1, 103-2, ..., 103-N, a digital/analog (D/A) converting section 104-1, 104-2, ..., 104-N, and a transmission-system radio circuit section 105-1, 105-2, ..., 105-N.

The radio base station apparatus of Yuda further comprises a correcting branch 121 for computing a correcting value. The correcting value is to detect a frequency characteristic of amplitude/phase deviation in the transmitting-signal circuit section 105 and to correct a deviation thereof. A frequency-response correcting value detecting

section 114 is to detect a frequency characteristic of amplitude and phase deviation on a signal Sct4 from the correcting branch 121, on the basis of an output signal St2 of the weight operating section 102 in the transmitting branch.

Thus, according to Yuda, correction is performed in frequency domain, where a weighted signal is taken for comparison with a transmitted signal in block 114. In contrast, according to the present invention, correction is performed on the basis of a complex time domain IQ signal. Yuda, however, fails to disclose or suggest that correction is performed on the basis of a complex time domain IQ signal. Coersmeier fails to cure this deficiency in Yuda. Therefore, the combination of Coersmeier and Yuda does not disclose or suggest "N error correction units according to the N signal branches, each configured to perform error correction on the original complex time domain IQ signal of a respective signal branch by means of a correction function," as recited in claim 1 and similarly recited in claim 9. Similarly, the combination of Coersmeier and Yuda fails to disclose or suggest "a first calculating unit configured to calculate a processed complex time domain IQ signal of the signal branch from the processed real signal and the original complex time domain IQ signal of the signal branch," as recited in claim 6 and similarly recited in claims 14 and 15.

Claims 2, 5, 7, 8, 10, 13 and 17 are dependent upon claims 1, 6, 9, and 15, respectively. Accordingly, claims 2, 5, 7, 8, 10, 13 and 17 should be allowed for at least their dependence upon claims 1, 6, 9, and 15, and for the specific limitations recited therein.

Claims 3 and 11 were rejected under 35 U.S.C. §103(a) as being unpatentable over Coersmeier and Yuda, further in view of Heiskala (U.S. Patent No. 6,700,453). The rejection is traversed for at least the following reasons.

Coersmeier and Yuda are discussed above. Heiskala discloses a method and arrangement for compensating for amplitude imbalance of a quadrature modulator. The method includes determining a first correlation on the basis of a first modulation signal and an output signal of the quadrature modulator, determining a second correlation on the basis of a second modulation signal and the output signal of the quadrature modulator, producing a compensation signal proportional to the amplitude imbalance on the basis of a ratio of the determined correlations and the first and second modulation signals, and processing at least one of the modulation signals of the quadrature modulator with the compensation signal.

Claims 3 and 11 are dependent upon claims 1 and 9, respectively. As discussed above, Coersmeier and Yuda do not disclose or suggest all of the elements of claims 1 and 9. Furthermore, Heiskala does not cure the deficiencies in Coersmeier and Yuda, as Heiskala also does not disclose "N error correction units according to the N signal branches, each configured to perform error correction on the original complex time domain IQ signal of a respective signal branch by means of a correction function." Thus, the combination of Coersmeier, Yuda and Heiskala does not disclose or suggest all of the elements of claims 3 and 11. Additionally, claims 3 and 11 should be allowed for at least their dependence upon claims 1 and 9, and for the specific limitations recited therein.

Claims 4 and 12 were rejected under 35 U.S.C. §103(a) as being unpatentable over Coersmeier, Yuda, and Heiskala, and further in view of Shirali (U.S. Patent No. 7,085,330). The rejection is respectfully traversed for at least the following reasons.

Coersmeier, Yuda, and Heiskala are discussed above. Shirali discloses a signal processing method and apparatus capable of correcting signal distortion introduced by an RF power amplifier. Shirali teaches the use of a buffer to store a plurality of samples representing at least a portion of an input signal intended for amplification by the RF power amplifier, the use of a self-receiver to receive an output signal generated by the RF power amplifier, the use of a synchronization unit to determine, as a matching input sample, which of the stored plurality of samples corresponds most closely to the output signal, and the use of a predistortion unit to selectively apply a distortion correction function to the input signal prior to amplification by the RF power amplifier in which the distortion correction function being derived from a relationship between the matching input sample and the output signal.

Claims 4 and 12 are dependent upon claims 1 and 9, respectively. As discussed above, Coersmeier, Yuda, and Heiskala do not disclose or suggest all of the elements of claims 1 and 9. Furthermore, Shirali does not cure the deficiencies in Coersmeier, Yuda and Heiskala, as Shirali also does not disclose "N error correction units according to the N signal branches, each configured to perform error correction on the original complex time domain IQ signal of a respective signal branch by means of a correction function." Thus, the combination of Coersmeier, Yuda, Heiskala and Shirali does not disclose or

suggest all of the elements of claims 4 and 12. Additionally, claims 4 and 12 should be allowed for at least their dependence upon claims 1 and 9, and for the specific limitations recited therein.

For at least the reasons discussed above, Applicants respectfully submit that the cited prior art fails to disclose or suggest all of the elements of the claimed invention. These distinctions are more than sufficient to render the claimed invention unanticipated and unobvious. It is therefore respectfully requested that all of claims 1-15 and 17-19 be allowed, and this application passed to issue.

If for any reason the Examiner determines that the application is not now in condition for allowance, it is respectfully requested that the Examiner contact, by telephone, the applicant's undersigned attorney at the indicated telephone number to arrange for an interview to expedite the disposition of this application.

In the event this paper is not being timely filed, the applicant respectfully petitions for an appropriate extension of time. Any fees for such an extension together with any additional fees may be charged to Counsel's Deposit Account 50-2222.

Respectfully submitted,

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